Scaling Analysis of the China France Oceanography Satellite Along Track Wind and Wave Data

Yang Gao1,2, Francois G Schmitt2, Jianyu Hu1,3, Yongxiang Huang1,3,4

1State Key Laboratory of Marine Environmental Science & College of Ocean and Earth Sciences, Xiamen University, Xiamen 361102, China
2CNRS, Univ. Lille, Univ. Littoral Cote d'Opale, UMR 8187, LOG, Laboratoire d'Océanologie et de Géosciences, F 62293 Wimereux, France
3South Marine Science and Engineering Guangdong Laboratory (Zhuhai), Zhuhai 519000, China
4State Key Laboratory of Marine Environmental Science & College of Ocean and Earth Sciences, Xiamen University, Xiamen 361102, China

Abstract

Fourier power spectrum analysis and second-order structure function analysis are performed to the China France Oceanography Satellite along track wind speed (WS) and significant wave height (Hs) data. The measured Fourier power spectrum of WS data exhibits power-law features in the ranges of 30 to 2500 km with the scaling exponents β close to 5/3 and 2 in the higher and lower wavenumber ranges respectively. For Hs data, the Fourier power spectrum illustrates similar scaling behaviors. The measured second-order structure functions confirm the existence of the power-law features. Furthermore, the latitudinal variations of scaling exponents are observed. Our preliminary results confirm the relevance of using multiscale statistical tools to characterize the movement of both ocean and atmosphere.

Data

- Wind-field scatterometer provided wind speed (WS) data with swath width of about 1000 km in 12.5 km resolution.
- Surface waves investigation and monitoring radar observed significant wave height (Hs) data in a resolution about 1.5 km.
- WS data are from December 18, 2018 to present.
- Hs data are from July 29, 2019 to present.
- The lines longer than 7000 km and have 95% or more good data are accepted to do Fourier power analysis.

Method

1) Fourier power spectrum analysis

\[ \tilde{E}(k) = \int_{-\infty}^{\infty} \rho(r) \cos(2\pi kr) dr \]

\[ E(k) \propto k^{-\beta} \]

\[ \rho(r) = \frac{1}{M(T)} \sum_{i=1}^{N(T)} \delta(x_i + r) \delta(y_i) \]

\[ \delta(x) = \theta(x) - \theta(x) \geq 0 \]

2) Structure function analysis

\[ S_q(r) = \langle |\Delta r|^q \rangle \]

\[ S_q(r) \propto r^\zeta(q) \]

4 Measured 2/3 power law

Summary

(a) Scaling features of the CFOSAT along track wind and wave data are observed by the Fourier power spectrum analysis and second-order structure function analysis.

(b) The scaling exponents measured from the WS and Hs both illustrate latitudinal variations is different scales.